# Harvard Elionix Batch Export Script

## ReadMe

In [3]:

```
# Every part of this code works on LWPOLYINES and LWPOLYLINES ONLY
# If you are doing lithography, you should be using nothing else.
# If you have circles, you should explode them to polylines with fi
# All alignment marks are indicated by the bottom left corner of re
# The matrix layer should outline the extent of each device (a boun
# This code can take final dxfs ready for export to EBL and prepare
#     Export modes can be without global alignment (simple unaligne
#             Note that only 4 point alignment is available at this
#     All layers in "active layers" list will be written

# While this code was built to deal with matrixed device writing fo
# Simply set num_cols=num_rows=1 and make sure your device is surro
# This code can be easily modified to toggle other parameters in th
# See the BEAMER docs for how to export a flow to python gobj in or
# To implment not on the Harvard BEAMER computer, you will need to
# See the companion DXFPreprocessing Script to generate matrixed de
# This code plots the nearest version of the input DXF used as an i

# PLEASE REPORT BUGS to aksaydjari@gmail.com (suggestiions/code con
```

executed in 16ms, finished 21:25:26 2020-05-30

## Import

In [4]:

```
import os
import sys
import datetime
import ezdxf
import numpy as np
import string
from itertools import chain
from scipy.spatial import ConvexHull
from itertools import repeat
import geopandas as gpd
import shapely
from shapely.geometry import Polygon, LineString
import matplotlib as mpl
import matplotlib.pyplot as plt
%matplotlib notebook
plt.style.use('dark_background')

sys.path.append("C:/Program Files/BEAMER/v5.9.1_x64")
sys.path.append("C:/Program Files/BEAMER/lib.0_x64")
import BEAMERpy
BEAMER = BEAMERpy.GBEAMER()
BEAMER.set_psf_archive_folder({ 'ArchivePath' : 'C:/Users/Public/Do
```

executed in 38ms, finished 21:25:27 2020-05-30

## User Area

In [5]:

```
# File Parameters
inputFileName = "QC0567p7_exportTest.dxf"
align_global_layer = "align_global_1"
align_local_layer = "align_local_1"
align_markers_layer = "align_marks"
matrix_layer = "matrix"
active_layers = ["TG"]

fabStepName = 'TG'

# Beamer Parameters
field = 500 # um
dots = 50000
current = 48 # nA
resistEBL = 'A4'
sampleName = 'QC0567p7'
baseDose = 2000 #uC/cm^2
dosefactor = 0.75
EBLprinter = 5 #5 or 6

# 1 == yes; 0 == no
local_align_on  = 1
global_align_on  = 1
ref_align_con_on = 0
pec_on = 0
psf_string = 'Substrate_GaAs_Thickness_700000_Energy_125_Layers_PMM
field_option = 'Floating' #'Floating' or 'Fixed'

## Temp Matrix Parameters
device_size_x = 860
device_size_y = 860
device_width_x = 860
device_width_y = 860
num_rows = 3                                #max is 9, if you are writi
num_cols = 3                                #collect more than $200 and
```

executed in 32ms, finished 21:25:28 2020-05-30

## Helper Functions

In [11]:

```
baseExportName = fabStepName + '_' + str(current) + 'nA' + '_' + re
globalExportName = 'global'+ '_' + fabStepName + '_' + sampleName +
baseDoseTime = (baseDose/current)*(field/dots)**2*10**(1) #us
```

executed in 16ms, finished 21:26:33 2020-05-30

In [12]:

```
def point_in_hull(point, hull, tolerance=1e-12):
    return all(
        (np.dot(eq[:-1], point) + eq[-1] <= tolerance)
        for eq in hull.equations)
def grabAlignPoints(msp, align_layer):
    align_points =[]
    lines = msp.query('LWPOLYLINE[layer=="{}"]'.format(align_layer)
    for idx, e in enumerate(lines):
        polyLineVertices = []
        for j, ver in enumerate(e.vertices()):
            polyLineVertices.append(tuple(list((ver[0],ver[1]))))
        align_points.append(OrderPointsABCDElionix(polyLineVertices
    return align_points
def OrderPointsABCDElionix(pointList):
    ordering_list = np.rad2deg(list(map(np.arctan2,
                        [x[0] for x in pointList]-np.mean(pointList
                        [x[1] for x in pointList]-np.mean(pointList

    sorted_pts = [x for _,x in sorted(zip(ordering_list,[x[0:2] for
    switched_pts = [sorted_pts[0],sorted_pts[3],sorted_pts[1],sorte
    return switched_pts
def assignMatrixIndex(filename,matrix_indices,active_layers,align_l
    df = importDXFtoGPDwPolygons(filename)

    boolOut = gpd.GeoDataFrame([])
    for idny, n in enumerate(matrix_indices):
        for idnx, x in enumerate(active_layers):
            temp = gpd.GeoDataFrame([])
            temp = relabelPostBool(boolAnd(df,'mask_{}'.format(n),x
            boolOut = boolOut.append(temp, ignore_index=True)
    boolOut = boolOut.append(df[df['Layer'] == align_local_layer])
    return boolOut
def importDXFtoGPDwPolygons(fileName):
    df = gpd.read_file(fileName)
    df1 = df[df['SubClasses'] == 'AcDbEntity:AcDbPolyline']
    df2 = df1.copy()
    df2['geometry'] = df1['geometry'].apply(lambda x: Polygon(x.coo
    return df2
def exportGPDwPolygonstoDXF(df):
    df1 = df.copy()
    df1['geometry'] = df['geometry'].apply(lambda x: LineString(x.e
    return df1
def relabelPostBool(df):
    sep = '_'
    df['Layer'] = df.apply(lambda x: sep.join((x.Layer_2,x.Layer_1.
    cols = df.columns.tolist()
```

```
    cols = cols[-1:] + cols[7:-2] + cols[-2:-1]
    df1 = df[cols]
    return df1.rename(columns = {x: x.split('_')[0] for x in cols[1
def boolAnd(df,layer1,layer2):
    dfa = df[df['Layer'] == layer1]
    dfb = df[df['Layer'] == layer2]
    return gpd.GeoDataFrame(gpd.overlay(dfa, dfb, how='intersection
def resaveWLayerColor(fileName, layerDict):
    doc = ezdxf.readfile(fileName)
    modelspace = doc.modelspace()
    for layer in doc.layers:
        splitName = layer.dxf.name.split('_')
        if len(splitName)>1 and splitName[-1].isnumeric():
            if splitName[-1] in matrix_indices:
                layer.color = layerDict[layer.dxf.name.split('_')[0
            else:
                layer.color = layerDict[layer.dxf.name]
        else:
            layer.color = layerDict[layer.dxf.name]
    for e in modelspace.query('LWPOLYLINE'):
        e.dxf.flags = 1
    doc.saveas('{}_c.dxf'.format(os.path.splitext(fileName)[0]))
def getLayerDic(doc):
    layers = doc.layers
    return {lay.dxf.name: lay.color for lay in layers}
```

executed in 40ms, finished 21:26:34 2020-05-30

In [13]:

```
doc = ezdxf.readfile(inputFileName)
modelspace = doc.modelspace()
for e in modelspace.query('LWPOLYLINE'):
    if e.closed == 0:
        print('You have open polylines. Go use linkCAD')
```

executed in 603ms, finished 21:26:35 2020-05-30

## SCON Single Field No Alignment

In [14]:

```
if global_align_on == 0:↔
```

executed in 57ms, finished 21:26:36 2020-05-30

## SCON Global Alignment Marks Only

In [15]:

```
global_pts_list = grabAlignPoints(modelspace,align_global_layer)

if np.logical_and(len(global_pts_list)==4,global_align_on):
    swtiched_global_pts = OrderPointsABCDElionix(global_pts_list)
    final_global_pts = [tuple(map(lambda y: y*10**(-3),x)) for x in

    layer_set = ''
    for x in active_layers:
        if active_layers.index(x) == 0:
            layer_set = layer_set + x
        else:
            layer_set = layer_set + ',' + x

    gobj_1 = BEAMER.import_dxf( {
    'LayerSet' : '*',
    'DXFUnits' : 'um',
    'DXFPolyMode' : 'ConvertToPolygon',
    'MaxErrorForConversion' : 0.001000,
    'SnappingRange' : 0.000500,
    'DXFDatabaseGrid' : 0.001000,
    'UseDXFInternalPrecision' : True,
    'ConvertDXFColorToDatatype' : False,
    'LoadTextElements' : False,
    'ConvertTextElementsToPolys' : False,
    'PreserveSingleLines' : False,
    'KeepElementOrder' : False,
    'ConvertedTextSize' : 1.000000,
    'PreserveSingleLines' : False,
    'FileName' : inputFileName } )

    gobj_2 = BEAMER.extract( gobj_1, {
    'ExtentMode' : 'Default',
    'ExtractMode' : 'EntireLayoutExtract',
    'CellName' : '',
    'LayerSet' : layer_set,
    'RegionLayer' : '',
    'RegionLayerBehavior' : 'Clip',
    'AllExceptForRegions' : False,
    'DoseClassificationShrink' : 0,
    'KeepRegionLayer' : False,
    'ExtractBoxes' : [] } )

    gobj_3 = BEAMER.filter( gobj_2, { 'SelectionList' : [{
        'GlobalMode' : 'AND',
        'TargetLayer' : 'KeepLayer',
        'TargetLayerName' : '',
```

```
            'RuleList' : [{'Attribute' : 'RelativeDose', 'Criteria1' :

    if EBLprinter == 5:
        gobj_4 = BEAMER.export_con( gobj_3, {
            'FileName' : globalExportName,
            'ExtentMode' : 'Default',
            'LowerLeftX' : 0.000000,
            'LowerLeftY' : 0.000000,
            'UpperRightX' : 0.000000,
            'UpperRightY' : 0.000000,
            'FormatType' : 'SCON',
            'FieldSizeX' : format(field, '.5f'),
            'FieldSizeY' : format(field, '.5f'),
            'DotNumber' : dots,
            'MaximumFieldSize' : field,
            'BaseDoseTime' : format(baseDoseTime, '.5f'),
            'RectangleOrientation' : 'X_AND_Y',
            'PitchSize' : 1,
            'NumberGlobalMarks' : 4,
            'MarkA_X' : format(final_global_pts[0][0], '.5f'), 'Mar
            'MarkB_X' : format(final_global_pts[1][0], '.5f'), 'Mar
            'MarkC_X' : format(final_global_pts[2][0], '.5f'), 'Mar
            'MarkD_X' : format(final_global_pts[3][0], '.5f'), 'Mar
            'LocalMarkCommand' : 'None',
            'LocalMarkPositionX1' : 0.000000, 'LocalMarkPositionY1'
            'LocalMarkPositionX2' : 0.000000, 'LocalMarkPositionY2'
            'LocalMarkPositionX3' : 0.000000, 'LocalMarkPositionY3'
            'LocalMarkPositionX4' : 0.000000, 'LocalMarkPositionY4'
            'RegionLayer' : '',
            'FieldTraversalType' : 'Fixed',
            'FixedFieldTraversal' : 'MeanderX',
            'FractureMode' : 'Curved',
            'CurveTolerance' : 1.000000,
            'ShotPitchAlignment' : 'NONE',
            'DoseTimeInterpolation' : False,
            'ReplaceFiles' : False,
            'GenerateFolder' : False,
            'GenerateCCCFiles' : True,
            'GenerateCPGData' : True,
            'GenerateParallelograms' : False,
            'KeepLayoutPosition' : True,
            'CenterFieldFrames' : False,
            'AdaptDoseToShotPitch' : 'CONSTANT',
            'AreaSelection' : 'SelectedThenRemainder',
            'FeatureOrderingType' : 'NoCompaction',
            'CompRegSize' : 500,
```

```
            'RegTraversal' : 'MeanderX',
            'SortedOrderLayer' : '*',
            'DoseMapping' : 'DoseToTime',
            'FieldOverlapX' : 0.000000,
            'FieldOverlapY' : 0.000000,
            'OverlapMethod' : 'Share between Fields',
            'InterleavingSize' : 0.000000,
            'InterlockLayer' : '*',
            'MultipassMode' : 'Single Pass',
            'MultipassFieldArrangement' : 'Shortest Path',
            'MainfieldOffsetX' : 0.500000,
            'MainfieldOffsetY' : 0.500000,
            'SubfieldOffsetX' : 0.000000,
            'SubfieldOffsetY' : 0.000000,
            'MultipassLayer' : '*',
            'UserDosePass' : [],
            'RegionList' : [] } )
    elif EBLprinter == 6:
        with open('EL6_alignment.txt','w') as f:
            print('AX {}'.format(final_global_pts[0][0], '.5f'), fi
            print('AY {}'.format(final_global_pts[0][1], '.5f'), fi

            print('BX {}'.format(final_global_pts[1][0], '.5f'), fi
            print('BY {}'.format(final_global_pts[1][1], '.5f'), fi

            print('CX {}'.format(final_global_pts[2][0], '.5f'), fi
            print('CY {}'.format(final_global_pts[2][1], '.5f'), fi

            print('DX {}'.format(final_global_pts[3][0], '.5f'), fi
            print('DY {}'.format(final_global_pts[3][1], '.5f'), fi
    else:
        print("That EBL instrument is not yet implemented")
```

executed in 1.93s, finished 21:26:39 2020-05-30

## SCON Reference For Alignment Mark Selection Check

In [16]:

```
if ref_align_con_on == 1:

    fileExportName = 'alignRef_{}'.format(baseExportName)

    gobj_13 = BEAMER.import_dxf( {
    'LayerSet' : '*',
    'DXFUnits' : 'um',
    'DXFPolyMode' : 'ConvertToPolygon',
    'MaxErrorForConversion' : 0.001000,
    'SnappingRange' : 0.000500,
    'DXFDatabaseGrid' : 0.001000,
    'UseDXFInternalPrecision' : True,
    'ConvertDXFColorToDatatype' : False,
    'LoadTextElements' : False,
    'ConvertTextElementsToPolys' : False,
    'PreserveSingleLines' : False,
    'KeepElementOrder' : False,
    'ConvertedTextSize' : 1.000000,
    'PreserveSingleLines' : False,
    'FileName' : inputFileName } )

    gobj_23 = BEAMER.extract( gobj_13, {
        'ExtentMode' : 'Default',
        'ExtractMode' : 'EntireLayoutExtract',
        'CellName' : '',
        'LayerSet' : align_markers_layer,
        'RegionLayer' : '',
        'RegionLayerBehavior' : 'Clip',
        'AllExceptForRegions' : False,
        'DoseClassificationShrink' : 0,
        'KeepRegionLayer' : False,
        'ExtractBoxes' : [] } )
    if EBLprinter == 5:
        gobj_33 = BEAMER.export_con( gobj_23, {
            'FileName' : fileExportName,
            'ExtentMode' : 'Default',
            'LowerLeftX' : 0.000000,
            'LowerLeftY' : 0.000000,
            'UpperRightX' : 0.000000,
            'UpperRightY' : 0.000000,
            'FormatType' : 'SCON',
            'FieldSizeX' : format(field, '.5f'),
            'FieldSizeY' : format(field, '.5f'),
            'DotNumber' : dots,
            'MaximumFieldSize' : field,
            'BaseDoseTime' : format(baseDoseTime, '.5f'),
```

```
'RectangleOrientation' : 'X_AND_Y',
'PitchSize' : 1,
'NumberGlobalMarks' : 0,
'MarkA_X' : 0.000000, 'MarkA_Y' : 0.000000,
'MarkB_X' : 0.000000, 'MarkB_Y' : 0.000000,
'MarkC_X' : 0.000000, 'MarkC_Y' : 0.000000,
'MarkD_X' : 0.000000, 'MarkD_Y' : 0.000000,
'LocalMarkCommand' : 'None',
'LocalMarkPositionX1' : 0.000000, 'LocalMarkPositionY1'
'LocalMarkPositionX2' : 0.000000, 'LocalMarkPositionY2'
'LocalMarkPositionX3' : 0.000000, 'LocalMarkPositionY3'
'LocalMarkPositionX4' : 0.000000, 'LocalMarkPositionY4'
'RegionLayer' : '',
'FieldTraversalType' : 'Fixed',
'FixedFieldTraversal' : 'MeanderX',
'FractureMode' : 'Curved',
'CurveTolerance' : 1.000000,
'ShotPitchAlignment' : 'NONE',
'DoseTimeInterpolation' : False,
'ReplaceFiles' : False,
'GenerateFolder' : False,
'GenerateCCCFiles' : True,
'GenerateCPGData' : True,
'GenerateParallelograms' : False,
'KeepLayoutPosition' : True,
'CenterFieldFrames' : False,
'AdaptDoseToShotPitch' : 'CONSTANT',
'AreaSelection' : 'SelectedThenRemainder',
'FeatureOrderingType' : 'NoCompaction',
'CompRegSize' : 500,
'RegTraversal' : 'MeanderX',
'SortedOrderLayer' : '*',
'DoseMapping' : 'DoseToTime',
'FieldOverlapX' : 0.000000,
'FieldOverlapY' : 0.000000,
'OverlapMethod' : 'Share between Fields',
'InterleavingSize' : 0.000000,
'InterlockLayer' : '*',
'MultipassMode' : 'Single Pass',
'MultipassFieldArrangement' : 'Shortest Path',
'MainfieldOffsetX' : 0.500000,
'MainfieldOffsetY' : 0.500000,
'SubfieldOffsetX' : 0.000000,
'SubfieldOffsetY' : 0.000000,
'MultipassLayer' : '*',
'UserDosePass' : [],
```

```
            'RegionList' : [] } )
    elif EBLprinter == 6:
        gobj_33 = BEAMER.export_car( gobj_23, {
            'FileName' : fileExportName.split('.')[0] + '.car',
            'ExtentMode' : 'Minimum',
            'LowerLeftX' : 0.000000,
            'LowerLeftY' : 0.000000,
            'UpperRightX' : 0.000000,
            'UpperRightY' : 0.000000,
            'ReplaceFiles' : False,
            'GenerateFolder' : True,
            'FormatType' : 'Fixed subfield',
            'MaximumFieldSize' : field,
            'SubfieldSize' : 10.0,
            'FieldSizeX' : format(field, '.5f'),
            'FieldSizeY' : format(field, '.5f'),
            'PitchSize' : 1,
            'AdaptDoseToShotPitch' : 'CONSTANT',
            'RectangleOrientation' : 'X_AND_Y',
            'GenerateCPGData' : True,
            'GenerateParallelograms' : False,
            'FieldTraversalType' : field_option,
            'KeepLayoutPosition' : True,
            'FractureMode' : 'Curved',
            'CurveTolerance' : 1.000000,
            'SymmetricFracturing' : False,
            'ShotPitchAlignment' : 'NONE',
            'FeatureOrderingType' : 'FixedSubfields',
            'SortedOrderLayer' : '*',
            'CompRegSize' : field,
            'RegTraversal' : 'MeanderX',
            'FixedSubfieldOrigin' : 'CenterToCenter',
            'LocalMarkCommand' : 'None',
            'LocalMarkPositionX1' : 0.000000,
            'LocalMarkPositionY1' : 0.000000,
            'LocalMarkPositionX2' : 0.000000,
            'LocalMarkPositionY2' : 0.000000,
            'LocalMarkPositionX3' : 0.000000,
            'LocalMarkPositionY3' : 0.000000,
            'LocalMarkPositionX4' : 0.000000,
            'LocalMarkPositionY4' : 0.000000,
            'FieldAlignmentCommand' : 'None',
            'FieldMarkPosition1X' : 0.000000,
            'FieldMarkPositionY' : 0.000000,
            'FieldMarkPosition2X' : 0.000000,
            'FieldMarkPosition2Y' : 0.000000,
```

```
            'FinePitch_X' : '',
            'FinePitch_Y' : '',
            'Moving_Z' : '',
            'MovingXY_X' : '',
            'MovingXY_Y' : '',
            'FieldOverlapX' : 0.000000,
            'FieldOverlapY' : 0.000000,
            'MultipassMode' : 'Single Pass' } )
    else:
            print("That EBL instrument is not yet implemented")
```

executed in 40ms, finished 21:26:40 2020-05-30

## Assign Device Indices and Resave

In [17]:

```
## Finds the bottom left-most corner of all device bounding boxes
matrix = modelspace.query('LWPOLYLINE[layer=="{}"]'.format(matrix_l

normMin = 1e12
idxMin = -1
idyMin = -1

for idx, e in enumerate(matrix):
    for idy, a in enumerate(e.vertices()):
        if np.linalg.norm(a) < np.linalg.norm(normMin):
            normMin = np.linalg.norm(a)
            idxMin = idx
            idyMin = idy

lowerLeft = [i for i in matrix[idxMin].vertices()]
base_x = lowerLeft[idyMin][0] + device_size_x/2
base_y = lowerLeft[idyMin][1] + device_size_y/2

## Defines the matrix extents, creates a mask layer to use for Bool
## Device blocks are prior to write fields and define all shapes wh
## Each device has individual EBL files exported to the user can de
## which devices to sacrifice if short on time
matrix_indices = [str(x+y) for x in range(10,(num_rows+1)*10,10) fo

for n in matrix_indices:
    points = np.array([
    (base_x+device_size_x*(int(n[1])-1)+device_size_x/2, base_y+dev
    (base_x+device_size_x*(int(n[1])-1)+device_size_x/2, base_y+dev
    (base_x+device_size_x*(int(n[1])-1)-device_size_x/2, base_y+dev
    (base_x+device_size_x*(int(n[1])-1)-device_size_x/2, base_y+dev
    ])
    modelspace.add_lwpolyline([tuple(points[0]),tuple(points[1]),tu
                               dxfattribs={'layer': 'mask_{}'.format

    temp = modelspace.query('LWPOLYLINE[layer=="{}"]'.format('mask_
    for e in temp:
        e.dxf.flags = 1

doc.saveas('{}_mask.dxf'.format(os.path.splitext(inputFileName)[0])

doc = ezdxf.readfile('{}_mask.dxf'.format(os.path.splitext(inputFil
layerDict = getLayerDic(doc)
boolOut = assignMatrixIndex('{}_mask.dxf'.format(os.path.splitext(i
exportGPDwPolygonstoDXF(boolOut).to_file('{}_split.dxf'.format(os.p
resaveWLayerColor('{}_split.dxf'.format(os.path.splitext(inputFileN
```

```
## Finds all local alignment marks and all polylines in the active
doc1 = ezdxf.readfile('{}_split_c.dxf'.format(os.path.splitext(inpu
modelspace1 = doc1.modelspace()

local_pts = grabAlignPoints(modelspace1,align_local_layer)

poly_query = 'LWPOLYLINE['
for i in range(len(tuple(['{}_{}'.format(x,y) for x in active_layer
    if i == 0:
        poly_query = poly_query +'layer=="{}"'
    else:
        poly_query = poly_query + '|layer=="{}"'
poly_query = poly_query + ']'

polyobj = modelspace1.query(poly_query.format(*tuple('{}_{}'.format

## Counts number of shapes in active layers actually in each device
## Assigns local alignment marks to device blocks if local alignmen
local_pts_dic = {}
subscript_active_layer_dic = {}
final_active_layers = {}
num_obj_dic = {x: 0 for x in matrix_indices}
open_poly_flag = 0

for n in matrix_indices:
    points = np.array([
    (base_x+device_size_x*(int(n[1])-1)+device_width_x/2, base_y+de
    (base_x+device_size_x*(int(n[1])-1)+device_width_x/2, base_y+de
    (base_x+device_size_x*(int(n[1])-1)-device_width_x/2, base_y+de
    (base_x+device_size_x*(int(n[1])-1)-device_width_x/2, base_y+de
    ])
    hull = ConvexHull(points)
    for e in polyobj:
        if all(list(map(point_in_hull, e.vertices(), repeat(hull)))
            num_obj_dic[n] = num_obj_dic[n] + 1
            if num_obj_dic[n] == 1:
                subscript_active_layer_dic.setdefault(n, []).append
            else:
                if e.dxf.layer not in subscript_active_layer_dic[n]
                    subscript_active_layer_dic[n].append(e.dxf.laye
            if e.dxf.flags != 1:
                open_poly_flag = open_poly_flag + 1
    if num_obj_dic[n] > 0:
        final_active_layers[n] = list(set(subscript_active_layer_di
    for e in local_pts:
        if point_in_hull(e,hull):
```

```
                #e.dxf.layer = '{}_{}'.format(e.dxf.layer,n)
                local_pts_dic.setdefault(n, []).append(e)


doc1.saveas('{}_align.dxf'.format(os.path.splitext(inputFileName)[0
```

executed in 1.96s, finished 21:26:43 2020-05-30

## SCON Device Fields (Local Alignment Optional)

In [20]:

```
if global_align_on == 1:

    #Plot the final dxf file which was written to EBL
    df = gpd.read_file('{}_align.dxf'.format(os.path.splitext(input
    ax = df.plot(column='Layer', cmap='Dark2')
    ax.set_facecolor((0, 0, 0))

    gobj_12 = BEAMER.import_dxf( {
    'LayerSet' : '*',
    'DXFUnits' : 'um',
    'DXFPolyMode' : 'ConvertToPolygon',
    'MaxErrorForConversion' : 0.001000,
    'SnappingRange' : 0.000500,
    'DXFDatabaseGrid' : 0.001000,
    'UseDXFInternalPrecision' : True,
    'ConvertDXFColorToDatatype' : False,
    'LoadTextElements' : False,
    'ConvertTextElementsToPolys' : False,
    'PreserveSingleLines' : False,
    'KeepElementOrder' : False,
    'ConvertedTextSize' : 1.000000,
    'PreserveSingleLines' : False,
    'FileName' : '{}_align.dxf'.format(os.path.splitext(inputFileNa

    fieldDoseTotal = {}
    fieldDoseMin = {}
    for n in matrix_indices:

        if num_obj_dic[n] > 0:
            dose_list = []
            for x in final_active_layers[n]:
                dose_list.append([x,dosefactor])

            layer_set = ''
            for x in final_active_layers[n]:
                if final_active_layers[n].index(x) == 0:
                    layer_set = layer_set + x
                else:
                    layer_set = layer_set + ',' + x

            fileExportName = '{}_{}'.format(n,baseExportName)

            gobj_22 = BEAMER.extract( gobj_12, {
                'ExtentMode' : 'Default',
                'ExtractMode' : 'EntireLayoutExtract',
                'CellName' : '',
```

```
        'LayerSet' : layer_set,
        'RegionLayer' : '',
        'RegionLayerBehavior' : 'Clip',
        'AllExceptForRegions' : False,
        'DoseClassificationShrink' : 0,
        'KeepRegionLayer' : False,
        'ExtractBoxes' : [] } )

    fieldDoseTotal.setdefault(n, []).append(BEAMER.get_area

    gobj_32 = BEAMER.heal( gobj_22, {
        'TargetLayer' : '1(0)',
        'SoftFrame' : 0.300000,
        'HierarchicalProcessing' : True,
        'SelectedLayerSet' : layer_set,
        'LayerAssignment' : 'PerLayer',
        'ProcessingMode' : 'Healing' } )

    if pec_on == 1:
        gobj_42 = BEAMER.pec( gobj_32, {
            'UserdefinedDoseClassFile' : '**filename**',
            'MinFractureSizeMode' : 'Automatic',
            'BeamSize' : 0.010000,
            'DoseClassMode' : 'Accuracy',
            'MaxNumOfDoseClasses' : 256,
            'Accuracy' : 1.000000,
            'UserDefinedSeparationValue' : False,
            'SeparationValue' : 0.100000,
            'FractureGrid' : 0.010000,
            'MinFractureSize' : 0.100000,
            'MinFractureSizeShortRange' : 0.100000,
            'MinDoseFactor' : 0.100000,
            'MaxDoseFactor' : 10.000000,
            'LayerListForCorrection' : '*',
            'LayerListForFullCorrection' : layer_set,
            'LayerForFracture' : '*',
            'ContrastPartofLRPEC' : 100.000000,
            'PSFFileName' : '',
            'OverdoseFactor' : 1.000000,
            'PSFType' : 'Archive',
            'MidRangeActivationThreshold' : 2.000000,
            'SingleLineBeamWidth' : 0.000000,
            'IncludeSRCorrection' : False,
            'HierarchicShortRangePEC' : True,
            'HierarchicLongRangePEC' : False,
            'ConvergenceOutput' : False,
```

```
                'IncludeLateralDevelopment' : False,
                'LateralDevelopmentGrid' : 0.100000,
                'PSFArchiveIdentifierString' : psf_string,
                'CellsToKeep' : '',
                'Use2dLateralDevelopmentBias' : False } )
        else:
            gobj_42 = gobj_32


        gobj_52 = BEAMER.fda( gobj_42, {
            'AssignmentType' : 'Multiply',
            'AssignmentMode' : 'ByLayer',
            'LayerDoseList' : dose_list,
            'LayerDoseSigmaList' : [] } )

        fieldDoseMin.setdefault(n, []).append(BEAMER.get_min_do

        if local_align_on == 1:
            if n in local_pts_dic.keys():
                local_align_exist = 1
                swtiched_local_pts = OrderPointsABCDElionix(loc
                final_local_pts = [tuple(map(lambda y: y*10**(-
            else:
                local_align_exist = 0
        else:
            local_align_exist = 0

        if np.logical_and(local_align_exist,local_align_on):
            local_align_flag = 'RL4'

            if EBLprinter == 5:
                gobj_62 = BEAMER.export_con( gobj_52, {
                     'FileName' : fileExportName,
                     'ExtentMode' : 'Default',
                     'LowerLeftX' : 0.000000,
                     'LowerLeftY' : 0.000000,
                     'UpperRightX' : 0.000000,
                     'UpperRightY' : 0.000000,
                     'FormatType' : 'SCON',
                     'FieldSizeX' : format(field, '.5f'),
                     'FieldSizeY' : format(field, '.5f'),
                     'DotNumber' : dots,
                     'MaximumFieldSize' : field,
                     'BaseDoseTime' : format(baseDoseTime, '.5f
                     'RectangleOrientation' : 'X_AND_Y',
                     'PitchSize' : 1,
```

```
                'NumberGlobalMarks' : 0,
                'MarkA_X' : 0.000000, 'MarkA_Y' : 0.000000
                'MarkB_X' : 0.000000, 'MarkB_Y' : 0.000000
                'MarkC_X' : 0.000000, 'MarkC_Y' : 0.000000
                'MarkD_X' : 0.000000, 'MarkD_Y' : 0.000000
                'LocalMarkCommand' : local_align_flag,
                'LocalMarkPositionX1' : format(final_local
                'LocalMarkPositionX2' : format(final_local
                'LocalMarkPositionX3' : format(final_local
                'LocalMarkPositionX4' : format(final_local
                'RegionLayer' : '',
                'FieldTraversalType' : 'Floating',
                'FixedFieldTraversal' : 'MeanderX',
                'FractureMode' : 'Curved',
                'CurveTolerance' : 1.000000,
                'ShotPitchAlignment' : 'NONE',
                'DoseTimeInterpolation' : False,
                'ReplaceFiles' : False,
                'GenerateFolder' : False,
                'GenerateCCCFiles' : True,
                'GenerateCPGData' : True,
                'GenerateParallelograms' : False,
                'KeepLayoutPosition' : True,
                'CenterFieldFrames' : False,
                'AdaptDoseToShotPitch' : 'CONSTANT',
                'AreaSelection' : 'SelectedThenRemainder',
                'FeatureOrderingType' : 'NoCompaction',
                'CompRegSize' : 500,
                'RegTraversal' : 'MeanderX',
                'SortedOrderLayer' : '*',
                'DoseMapping' : 'DoseToTime',
                'FieldOverlapX' : 0.000000,
                'FieldOverlapY' : 0.000000,
                'OverlapMethod' : 'Share between Fields',
                'InterleavingSize' : 0.000000,
                'InterlockLayer' : '*',
                'MultipassMode' : 'Single Pass',
                'MultipassFieldArrangement' : 'Shortest Pa
                'MainfieldOffsetX' : 0.500000,
                'MainfieldOffsetY' : 0.500000,
                'SubfieldOffsetX' : 0.000000,
                'SubfieldOffsetY' : 0.000000,
                'MultipassLayer' : '*',
                'UserDosePass' : []} )
        elif EBLprinter == 6:
            gobj_62 = BEAMER.export_car( gobj_52, {
```

```
            'FileName' : fileExportName,
            'ExtentMode' : 'Minimum',
            'LowerLeftX' : 0.000000,
            'LowerLeftY' : 0.000000,
            'UpperRightX' : 0.000000,
            'UpperRightY' : 0.000000,
            'ReplaceFiles' : False,
            'GenerateFolder' : True,
            'FormatType' : 'Fixed subfield',
            'MaximumFieldSize' : field,
            'SubfieldSize' : 10.0,
            'FieldSizeX' : format(field, '.5f'),
            'FieldSizeY' : format(field, '.5f'),
            'PitchSize' : 1,
            'AdaptDoseToShotPitch' : 'CONSTANT',
            'RectangleOrientation' : 'X_AND_Y',
            'GenerateCPGData' : True,
            'GenerateParallelograms' : False,
            'FieldTraversalType' : field_option,
            'KeepLayoutPosition' : True,
            'FractureMode' : 'Curved',
            'CurveTolerance' : 1.000000,
            'SymmetricFracturing' : False,
            'ShotPitchAlignment' : 'NONE',
            'FeatureOrderingType' : 'FixedSubfields',
            'SortedOrderLayer' : '*',
            'CompRegSize' : field,
            'RegTraversal' : 'MeanderX',
            'FixedSubfieldOrigin' : 'CenterToCenter',
            'LocalMarkCommand' : local_align_flag,
            'LocalMarkPositionX1' : format(final_local_
            'LocalMarkPositionX2' : format(final_local_
            'LocalMarkPositionX3' : format(final_local_
            'LocalMarkPositionX4' : format(final_local_
            'FieldAlignmentCommand' : 'None',
            'FieldMarkPosition1X' : 0.000000,
            'FieldMarkPositionY' : 0.000000,
            'FieldMarkPosition2X' : 0.000000,
            'FieldMarkPosition2Y' : 0.000000,
            'FinePitch_X' : '',
            'FinePitch_Y' : '',
            'Moving_Z' : '',
            'MovingXY_X' : '',
            'MovingXY_Y' : '',
            'FieldOverlapX' : 0.000000,
            'FieldOverlapY' : 0.000000,
```

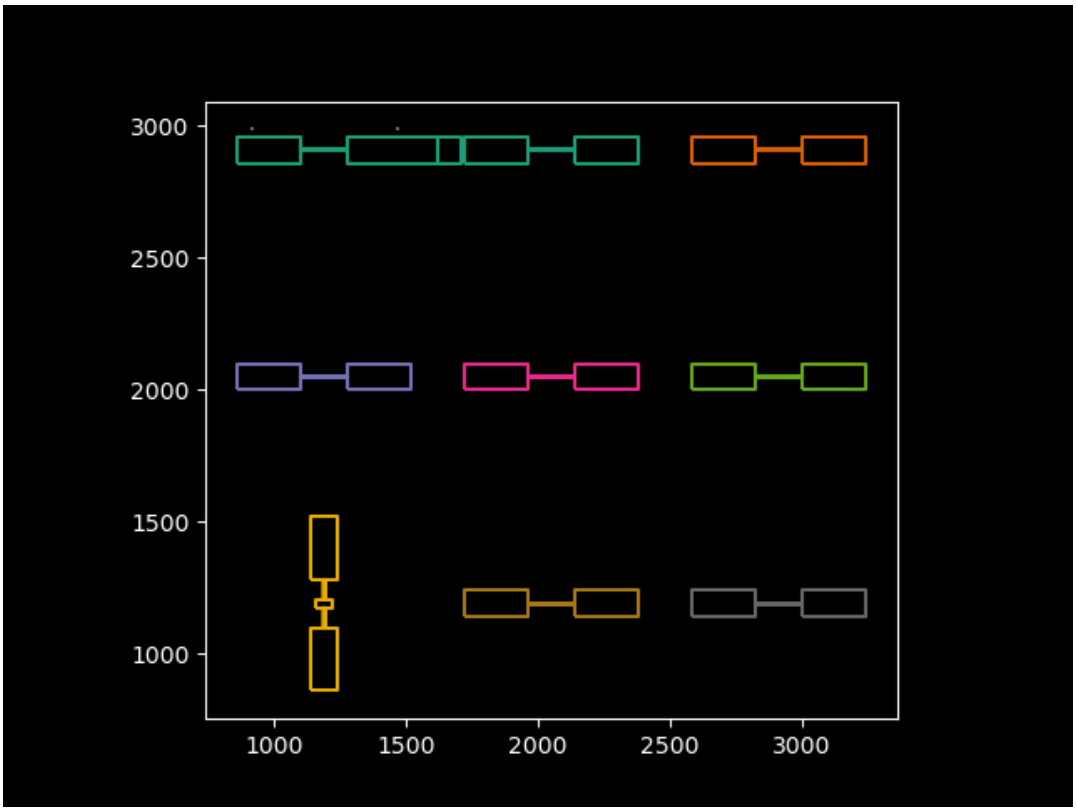
```
                    'MultipassMode' : 'Single Pass' } )
            else:
                    print("That EBL instrument is not yet imple

        else:
            local_align_flag = 'None'

            if EBLprinter == 5:
                gobj_62 = BEAMER.export_con( gobj_52, {
                    'FileName' : fileExportName,
                    'ExtentMode' : 'Default',
                    'LowerLeftX' : 0.000000,
                    'LowerLeftY' : 0.000000,
                    'UpperRightX' : 0.000000,
                    'UpperRightY' : 0.000000,
                    'FormatType' : 'SCON',
                    'FieldSizeX' : format(field, '.5f'),
                    'FieldSizeY' : format(field, '.5f'),
                    'DotNumber' : dots,
                    'MaximumFieldSize' : field,
                    'BaseDoseTime' : format(baseDoseTime, '.5f
                    'RectangleOrientation' : 'X_AND_Y',
                    'PitchSize' : 1,
                    'NumberGlobalMarks' : 0,
                    'MarkA_X' : 0.000000, 'MarkA_Y' : 0.000000
                    'MarkB_X' : 0.000000, 'MarkB_Y' : 0.000000
                    'MarkC_X' : 0.000000, 'MarkC_Y' : 0.000000
                    'MarkD_X' : 0.000000, 'MarkD_Y' : 0.000000
                    'LocalMarkCommand' : local_align_flag,
                    'LocalMarkPositionX1' : 0.000000, 'LocalMa
                    'LocalMarkPositionX2' : 0.000000, 'LocalMa
                    'LocalMarkPositionX3' : 0.000000, 'LocalMa
                    'LocalMarkPositionX4' : 0.000000, 'LocalMa
                    'RegionLayer' : '',
                    'FieldTraversalType' : field_option,
                    'FixedFieldTraversal' : 'MeanderX',
                    'FractureMode' : 'Curved',
                    'CurveTolerance' : 1.000000,
                    'ShotPitchAlignment' : 'NONE',
                    'DoseTimeInterpolation' : False,
                    'ReplaceFiles' : False,
                    'GenerateFolder' : False,
                    'GenerateCCCFiles' : True,
                    'GenerateCPGData' : True,
                    'GenerateParallelograms' : False,
                    'KeepLayoutPosition' : True,
```

```
                'CenterFieldFrames' : False,
                'AdaptDoseToShotPitch' : 'CONSTANT',
                'AreaSelection' : 'SelectedThenRemainder',
                'FeatureOrderingType' : 'NoCompaction',
                'CompRegSize' : 500,
                'RegTraversal' : 'MeanderX',
                'SortedOrderLayer' : '*',
                'DoseMapping' : 'DoseToTime',
                'FieldOverlapX' : 0.000000,
                'FieldOverlapY' : 0.000000,
                'OverlapMethod' : 'Share between Fields',
                'InterleavingSize' : 0.000000,
                'InterlockLayer' : '*',
                'MultipassMode' : 'Single Pass',
                'MultipassFieldArrangement' : 'Shortest Pa
                'MainfieldOffsetX' : 0.500000,
                'MainfieldOffsetY' : 0.500000,
                'SubfieldOffsetX' : 0.000000,
                'SubfieldOffsetY' : 0.000000,
                'MultipassLayer' : '*',
                'UserDosePass' : []} )
        elif EBLprinter == 6:
            gobj_62 = BEAMER.export_car( gobj_52, {
                'FileName' : fileExportName.split('.')[0] +
                'ExtentMode' : 'Minimum',
                'LowerLeftX' : 0.000000,
                'LowerLeftY' : 0.000000,
                'UpperRightX' : 0.000000,
                'UpperRightY' : 0.000000,
                'ReplaceFiles' : False,
                'GenerateFolder' : True,
                'FormatType' : 'Fixed subfield',
                'MaximumFieldSize' : field,
                'SubfieldSize' : 10.0,
                'FieldSizeX' : format(field, '.5f'),
                'FieldSizeY' : format(field, '.5f'),
                'PitchSize' : 1,
                'AdaptDoseToShotPitch' : 'CONSTANT',
                'RectangleOrientation' : 'X_AND_Y',
                'GenerateCPGData' : True,
                'GenerateParallelograms' : False,
                'FieldTraversalType' : field_option,
                'KeepLayoutPosition' : True,
                'FractureMode' : 'Curved',
                'CurveTolerance' : 1.000000,
                'SymmetricFracturing' : False,
```

```
                'ShotPitchAlignment' : 'NONE',
                'FeatureOrderingType' : 'FixedSubfields',
                'SortedOrderLayer' : '*',
                'CompRegSize' : field,
                'RegTraversal' : 'MeanderX',
                'FixedSubfieldOrigin' : 'CenterToCenter',
                'LocalMarkCommand' : local_align_flag,
                'LocalMarkPositionX1' : 0.000000, 'LocalMar
                'LocalMarkPositionX2' : 0.000000, 'LocalMar
                'LocalMarkPositionX3' : 0.000000, 'LocalMar
                'LocalMarkPositionX4' : 0.000000, 'LocalMar
                'FieldAlignmentCommand' : 'None',
                'FieldMarkPosition1X' : 0.000000,
                'FieldMarkPositionY' : 0.000000,
                'FieldMarkPosition2X' : 0.000000,
                'FieldMarkPosition2Y' : 0.000000,
                'FinePitch_X' : '',
                'FinePitch_Y' : '',
                'Moving_Z' : '',
                'MovingXY_X' : '',
                'MovingXY_Y' : '',
                'FieldOverlapX' : 0.000000,
                'FieldOverlapY' : 0.000000,
                'MultipassMode' : 'Single Pass' } )
        else:
                print("That EBL instrument is not yet imple
```

executed in 6.31s, finished 21:27:52 2020-05-30

```
<IPython.core.display.Javascript object>
```




In [21]:

```
if type(fieldDoseTotal) == float:
    doseTotalTime = fieldDoseTotal
else:
    doseTotalTime = sum([x[0] for x in fieldDoseTotal.values()])
if type(fieldDoseTotal) == float:
    doseMinTime = fieldDoseMin
else:
    doseMinTime = min([x[0] for x in fieldDoseMin.values()])
```

executed in 15ms, finished 21:27:58 2020-05-30

## Logging

In [22]:

```
with open('pythonLog.txt','w') as f:
    if doseMinTime < 0.01:
        print("Dose Time too Short! Decrease the current. Change th
    print("Base Dose = {} us/dot".format(baseDoseTime), file=f)
    print("Total Dose Time = {} hh:mm:ss".format(str(datetime.timed
    if open_poly_flag > 0:
        print('You have open polylines. Go use linkCAD', file=f)
if doseMinTime < 0.01:
    print("Dose Time too Short! Decrease the current. Change the nu
print("Base Dose = {} us/dot".format(baseDoseTime))
print("Total Dose Time = {} hh:mm:ss".format(str(datetime.timedelta
if open_poly_flag > 0:
    print('You have open polylines. Go use linkCAD')
```

executed in 16ms, finished 21:27:59 2020-05-30

```
Base Dose = 0.041666666666666664 us/dot
Total Dose Time = 0:21:58 hh:mm:ss
```

In [ ]: